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29 November 1956

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Dear Jim:

8/1/82

During the visit you made primarily for the purpose of discussing the concepts and requirements underlying System 5, you raised several questions with respect to the design and performance of System 4. We discussed some of the points raised while you were here and have since looked into several others.

You raised the question as to whether the basic electronic elements required for the 1-inch tape recorder and the camera indicator unit could be incorporated in these equipment items at an early date. Investigation reveals that these structures can indeed be given the configuration you desire at least by the time the second production unit is ready for delivery and very probably by the time the first unit is ready. We are in complete agreement on the desirability of this modification in design and will attempt to incorporate such changes as may be necessary at a date sufficiently early so that all of these units will be of identical configuration.

You inquired also whether the threshold setting suggested for the System 4 receivers was not unnecessarily high, thus tending to needlessly reduce effective receiver sensitivity. The following numerical data is presented primarily to indicate that the sensitivity values indicated earlier are fairly realistic in magnitude. To pinpoint the discussion, I shall assume that we are considering a receiver operating at X-band. The intermediate-frequency bandwidth shall be taken as 15 mc, and the post-detector video bandwidth will be taken as 5 mc. The corresponding effective noise-bandwidth of the receiver then becomes approximately 8.7 mc. For this value of bandwidth, the thermal noise level should approximate -104.5 dbm. Fixed-tuned, high quality X-band radar receivers in production at this time achieve a noise figure of 10 db with considerable difficulty, and a value of 12 db with comparative ease. Experience indicates, however, that the noise figure tends to deteriorate somewhat after the receiver is placed in service, so that a realistic operating value is apt to lie in the vicinity of 14 db. It would probably be difficult to match this performance with a tuning-type of receiver such as might be built around an APR-9 head. Accordingly, we are inclined to believe that it might be quite difficult to attain an average noise figure appreciably better than 15 db.

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A threshold setting 13.6 db above the rms noise level would cause false lock-on due to noise approximately once every 15 minutes. No significant reduction in threshold setting would result if one were willing to accept a false lock-on every few minutes.

Combining the figures indicated above, the effective lock-on sensitivity of the receiver is equal to -104 dbm plus 15 db plus 13.6 db, or approximately -76 dbm. If unusual care were exercised in the selection of mixer crystals, in input circuit impedance matching, and in selection of the first i-f amplifier tube, it might be possible to improve the receiver noise figure by 3 or 4 db, thus bringing the effective lock-on sensitivity to perhaps -80 dbm.

At the moment, I do not seem able to recall whether or not you mentioned an effective lock-on sensitivity value that you believed to be readily attainable. The basis for calculation of the sensitivity figures given in the preceding paragraphs, however, is well known and would seem to indicate that the tentative figures indicated in one of our earlier reports are generally in the right ball park. We cannot be more precise about lock-on sensitivity without gaining firsthand experience with the APR-9 heads. Perhaps you already have such experience and, if this should be more favorable than that which we anticipate, our figures should be revised accordingly. Otherwise, we believe the estimates of receiver sensitivity given are fairly realistic. We would welcome your comments on this subject.

Sincerely,

*Burt*

Burt

cc: George ✓

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